# LOSSES OF AMMONIACAL FERTILIZERS FROM SPRINKLER JETS

By D. W. HENDERSON, W. C. BIANCHI and L. D. DONEEN

*Department of Irrigation, University of California, Davis, Cal.*

THE APPLICATION OF soluble fertilizers through sprinkler systems is of considerable interest because of the possibility of reducing costs by eliminating special operations for fertilizer application. However it is well known that ammonia is a volatile substance, and that escape of ammonia from a solution to the atmosphere occurs to varying degrees.

Because of this fact farmers have been warned not to attempt application of anhydrous or aqua ammonia through sprinkler systems. It has not been so universally understood, however, that any solution which contains ammonium ions ($NH_4+$) also contains free ammonia ($NH_3$) which is subject to loss through volatilization. The aim of the investigation reported here was to determine the magnitude of possible losses of common ammoniacal fertilizers. Some of the factors affecting these losses were studied so that recommendations could be made for reducing them to a minimum.

### *Experimental Procedure*

The various solutions studied were made up with tap water in a 100 gallon galvanized iron tank and pumped from the tank through a part-circle sprinkler set to distribute water through an arc of about 25 degrees. Sixteen glass catch vessels approximately six inches in diameter were placed along the axis of the pie-shaped area covered by the sprinkler at intervals of two feet. A few grams of boric acid powder were placed in each catch vessel to prevent loss of ammonia from the vessel during the run, which was of 25 to 30 minutes duration, and during subsequent handling.

Shortly after the beginning of each run, a sample of the solution passing through the sprinkler nozzle was taken. The temperature and pH of the solution were determined immedaitely and the ammonia concentration measured by distillation and titration. The solutions in the catch vessels were composited for ammonia determinations.

Preliminary experiments indicated the need for correcting for water losses due to evaporation. This was accomplished by determining the increase in chloride concentration from the nozzle to the catch vessels. Since the chloride content of the tap water was small, enough sodium chloridle was added to bring the total chloride concentration up to approximately 150 ppm. This concentration is convenient for analysis, but is not sufficient to lower the vapor pressure of the water appreciably.

Losses of ammonia were computed from concentrations of samples taken from the sprinkler nozzle and concentrations of ammonia in the catch vessels. These observed losses were corrected for water loss by evaporation. Since losses from the catch vessels were prevented by addition of boric acid, the values reported are limited to volatilization from the jet.

Field application would probably result in greater losses since interception of water by crop foliage would allow more time for ammonia escape. Furthermore, losses from small droplets which drift out of the catch area would probably be greater because they are in the air for longer periods than that retained in the catch vessels. Losses from soil were not considered in this study since they presumably are small as long as the soil remains moist and are probaly similar in magnitude to those incurred in broadcast methods of fertilizer application.

A few tests were made with an operating pressure of 60 psi at the sprinkler, but in most instances the pressure was 40 psi. Tests were carried out at both these operating pressures, using the same fertilizer solution, and it was concluded that

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the effect of operating pressure was small under the conditions of these trials.

Wind velocity, air temperature and relative humidity were recorded for each test. Although no special attempt was made to study the effect of these climatic conditions on ammonia losses, it was observed that variations in duplicate determinations made under different weather conditions bore no consistent relationship to changes in the weather.

Solutions were made up from commercital fertilizers, except for aqua ammonia, for which C. P. ammonium hydroxide was used.

### *Results and Discussion*

Losses of ammonia from aqua ammonia, ammonium sulfate, ammonium nitrate and ammonium phosphat were studied in relation to the initial concentration of the fertilizer solution.

As would be expected, losses from aqua ammonia solutions were very high, and increased with initial concentration. Losses from solutions of ammonium salts were appreciable at low initial concentrations, but decreased rapidly as the initial concentration was increased.

Differences in the pH of the solutions after addition of the fertilizer materials accounts for much of the effect of initial concentration on ammonia losses. The tap water used to make up the solutions had a pH of 8.3. Addition of aqua ammonia increased the pH, but addition of the fertilizer salts studied decreased the pH through hydrolysis and the acidic materials remaining in the fertilizer salts from the manufacturing process. These data indicate that if ammonia losses from the sprinkler jet are to be kept below 10 per cent, the pH of the fertilizer solution should be 8.0 or less. Approximately 5 per cent loss can be expected at pH 7.5, and loss is negligible if the pH is 7.0 or below.

Many factors will affect the pH resulting from addition of fertilizer salts to a given irrigation water. The most important of these are the pH of the water, buffer capacity of the water (particularly $CO_3$ — + $HCO_3$ — content), the acidity of the fertilizer salt and the amount of fertilizer added to the water. Since irrigation waters vary in pH and buffer capacity and fertilizer salts vary in acid content, the simplest procedure for controlling losses would be to determine the pH of the irrigation water after the addition of fertilizer materials. The use of commercial indicators in the form of paper strips would make possible rapid field checks.

More general recommendations can be made. If the irrigation water is essentially neutral (pH less than 7.5), addition of any ammonium salt in appreciable quantity will reduce the pH to the extent that losses would be negligible. If the water has a pH of much above 7.5, losses can be reduced to a minimum by applying the fertilizer in the smallest possible amount of water which will not result in injury to the crop or sprinkler system.

## COMING EVENTS

**1955**

**Aug. 9-11:**
Third University of Florida Turf Conference, Gainesville, Fla. Dr. Gene C. Nutter

**Aug. 10-11:**
24th Annual Rhode Island Field Day, University of Rhode Island, Kingston, R. I. Dr. J. A. DeFrance.

**Aug. 15-19:**
American Society of Agronomy Meetings, Davis, Cal. L. G. Monthey.

**Aug. 20:**
Regional Field Day, Texas Turfgrass Association, San Antonio, Texas.

**Sept. 7-8:**
Penn State Field Days, Pennsylvania State University, State College, Pa. Prof. H. B. Musser.

**Sept. 23-24:**
Edmonton Turfgrass Conference, University of Alberta, Edmonton, Alberta, Canada. Prof. R. H. Knowles.

**Sept. 27-28:**
Northwest Turfgrass Conference, Pullman, Wash. Prof. A. G. Law.

**Sept. 30-Oct. 1:**
Utah Turfgrass Conference, Utah Copper Golf Course, Magna, Utah. J. W. Richardson.

**Oct. 3-4:**
Rocky Mountain Turfgrass Conference, Colorado A. & M. College, Fort Collins, Colo. Prof. George A. Beach.

The temperature of the irrigation water would presumably affect ammonia losses. A series of tests carried out with the same fertilizer solution (ammonium sulfate, 14 lbs. per acre inch) at temperature of 68, 77, and 90° F. gave observed losses of 5.2, 6.6, and 7.6 per cent, respectively. Losses may therefore be expected to increase as the water temperature increases. The water temperature for all other tests reported was approximately constant at 79° F.

Some of the factors affecting losses of ammoniacal fertilizers from sprinkler jets were investigated. The principal consideration is the pH of the fertilizer solution, which depends on characteristics of both the irrigation water and the fertilizer materials.

It should be emphasized that field application of ammonia fertilizers results in losses other than those from the jet. If the pH of the fertilizer solution being applied is kept as near neutral as practicable, losses would be reduced to a minimum.

*Editor's note: Figures showing results of these experiments graphically and references to those figures have been deleted from the original article.*

## Bengeyfield Succeeds Wilson

William H. Bengeyfield has succeeded Charles G. Wilson as Western Regional Director of the USGA Green Section. The Western Regional Office has been moved from Davis, Cal., to 1709 West Eighth Street, Los Angeles 17, Cal., and will be in the quarters of the Southern California Golf Association.

A student at Alfred University until his education was interrupted by war-

WILLIAM H. BENGEYFIELD

time service as navigator of an Air Force B-25 in the Pacific Theatre, Mr. Bengeyfield was graduated in 1948 from Cornell's